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ABSTRACT

College teachers of English for Science and Technology (EST) are encouraged to conduct research in preparation for designing appropriate writing instruction. Specific recommendations are made for creating such a program, providing adequate support, and organizing its content, with examples offered from the program in computer science writing at the University of Aizu (Japan). An EST writing program should offer student discipline-related knowledge, knowledge of writing in the discipline, and instructional activities tailored to specific skill levels and student needs. At the University of Aizu, instructional design research began with a survey of 87 computer science faculty, a review of professional literature, and computerized analyses of English grammatical constructions and vocabulary used most frequently in computer science discourse. The last analysis revealed 22 different kinds of writing within the field with four primary functions: to obtain approval or resources; organize information for efficient access; generate new information; and disseminate new information. Relevant writing genres for these functions were selected, including dialogues, object descriptions, narratives, process descriptions, and abstracts and bibliographies. Specialist, non-specialist, and high-frequency vocabulary and problematic grammatical constructions in computer science were also identified. Instructional activities were constructed using this information. (MSE)

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Technical Report 96-5-001

Designing English Writing Instruction for Students in the Science and Technologies: Research, Results, and Applications

Thomas Orr

September 21, 1996

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ESP (English for Specific Purposes), EST (English for Science and Technology), computer science, writing, genre, grammar, vocabulary, curriculum design

Abstract:
This presentation instructs college and university faculty how to conduct EST research in preparation for English writing instruction in the science and technologies. Examples are drawn from recent research and composition instruction at the University of Aizu.

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Designing English Writing Instruction for Students in the Science and Technologies: Research, Results, and Applications

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1 Introduction

Engendered by Selinker, Lackstrom and Trimble's research at the University of Washington in the 1960s and 70s,[1] English for Science and Technology has grown to become a major area of specialization within the field of English education. Research has multiplied to fill books and journals on the subject, and EST instruction has been established at major institutes of technology, departments of science, and government research centers all over the world. Today, there are EST programs in Hong Kong, France, Israel, Mexico, Brazil, Egypt, England, the Czech Republic, the Philippines, South Africa, Saudi Arabia, Canada, Ireland, Hungary, Thailand, the United States, and in many other nations as well. In Finland, for example, where educators take English education very seriously, there is an EST program, required by national law, at every school of science and technology in the country.

Japan is also very serious about English education, and recently, prompted by new priorities in government spending and the greater need for English in the science and technologies[2], interest in EST has never been higher.

In this paper, I would like to respond to Japan's interest in EST by briefly outlining how an EST writing program may be developed, at a college or university, to meet the unique English language needs of students majoring in science or technology.

2 Recommendations

I begin my recommendations by offering a good definition of EST.

Simply put, *English for Science and Technology* is "a cover term for all research and instructional activity designed to understand and support the effective use of English in scientific and technological

[1] See Trimble, 1985, p.1, 176-78 for some discussion of their early work and a list of their early publications.

[2] Apparently, one of the main factors influencing this heightened demand for English has been the success of Internet and World Wide Web for the dissemination and archival of vast amounts of profession-related information.

fields" (Orr, 1995a, p.3).

This means EST professionals do two things. One, they conduct research to *understand* English as it is used in the science and technologies; and two, EST professionals offer instruction to *support* the effective use of English in these areas.

The research duties of an EST professional are especially crucial. For unless both student and teacher have sufficient knowledge of the unique purposes and characteristics of English as it is used in a student's target field of study, writing instruction will be no different from that in general English writing courses, and thus, less effective in enabling students to successfully carry out profession-related tasks.

What does a good EST writing course include? I believe it must offer students three things:

2.1 Knowledge of the Discipline

ONE, there must be some specific and accurate information about the culture of the students' target field(s) of study.

Students need to know about the primary goals of their profession, the primary activities that its members engage in to accomplish these goals, and the values and cultural conventions that govern professional activities. EST writing instruction will not be motivating nor its purpose properly understood if students do not have general knowledge of the normal activities in their target discipline. This information can be provided by professors from the students' subject area(s), by EST writing professors, or by both in some sort of cooperative effort. Inviting scientists or engineers to class to talk about their profession, their work, and their writing is one effective way to accomplish this.

2.2 Knowledge of Writing in the Discipline

TWO, in addition to some general knowledge about their field and how writing fits into the scheme of things, students need to know about the written English discourse that is uniquely characteristic of their target discipline.

This should include information on the profession's genres and sub-genres, audiences, purposes, print and electronic formats, high-frequency grammatical forms, high-frequency vocabulary, mechanics, efficient means of writing and revision, dissemination factors, cultural/professional taboo, and so forth. A graphical representation of the genres and their features, along with many good examples, can be very useful to help students understand both linguistic detail as well as rhetorical purpose.

2.3 Instruction and Training for the Discipline

And **THREE**, an EST writing course must consist of appropriate instructional activities that are tailored to the specific language levels and personal characteristics of the learners. These activities must enable students to learn *about* the writing that is practiced in their discipline as well as enable them to learn *how to produce* this type of writing. Activities that allow students to produce writing in situations that approximate those of professionals are likely to be more effective. Imitative exercises without rhetorical contexts generally bore young writers and don't give them exposure to all the aspects of writing they will encounter in their careers. Team teaching with a content professor in the students' subject area can often provide one good solution to this problem.

2.4 Commitment to EST Research

How do you get the information you need about a profession and its writing for an EST writing course? You must gather most of it on your own or in cooperation with other writing teachers working with students in similar subject areas. Composition textbooks may, for example, give you information about some of the genres and formatting preferences of, say, engineering or biology, but they won't give you nearly enough detail on contextual factors. For an EST program to have detailed knowledge about English usage in the science and technologies, EST professors must be willing to devote the bulk of their careers to research in EST.[3] Short-term English teachers who merely dabble in EST will not be able to offer much substance to a university's EST program or to the field of EST in general.

3 Writing Research and Instruction at the University of Aizu

In order to illustrate EST writing research and instruction, I would like to briefly outline some of the research we have been conducting at the University of Aizu to create effective EST writing courses for our students in the computer sciences.

3.1 Source of Data

In the first stage of research, the primary source of data about written English discourse in computer science has been our university's computer faculty of approximately 87 members from 20 different

[3]EST research begins with trying to understand and describe English discourse in the science and technologies. As it progresses, however, it becomes more and more prescriptive, by recommending more efficient and effective means of communication.

nations. Surveys and short follow-up interviews were conducted with twenty-five members of the faculty, detailed case studies were conducted with two members of the faculty (one native and one non-native English writer), and additional information was gathered through surveys of professional literature in computer science along with computer-assisted analyses of English vocabulary and grammatical constructions appearing most frequently in computer science discourse. (See Orr, 1995b; Orr, Christianson, Goetze, & Okawara, 1995.)

Some of the information we gathered that is of particular use to our EST writing program is the following:

3.2 Definition of Computer Science

To assist our writing teachers and students understand the essence of computer science, we discovered that the Association of Computing Machinery (ACM), one of the main professional organizations for computer scientists, had a very clear description of the field.

According to the ACM, *Computer science is the systematic study of algorithmic processes that describe and transform information — the theory, analysis, design, efficiency, implementation, and application. The fundamental question underlying all computer science is "What can be efficiently automated?"*

3.3 Writing in Computer Science

When we looked at all the English writing that takes place in the computer profession, we found roughly twenty-two different kinds of writing. In broad terms, these could be categorized according to two general functions: 1) to manipulate *information* and 2) to manipulate *resources*. All other functions were simply small pragmatic steps toward one of these two larger goals.

To help students understand how these genres functioned more specifically within the profession, we developed a flow chart that grouped writing under four main categories and four sub-categories.

1) Storage-Directed Writing

Purpose: to select and manage the mental/physical storage of information

a) notational support

e.g., notes in the margins of journal articles or conference proceedings, etc.

b) organizational support

e.g., lists of information sources, facts, formulas, etc.

The role of writing in this aspect of professional work is often overlooked, and yet it is an important one, particularly in computer science where reading input is so immense. In our investigation of 25 computer scientists in our Department of Computer Hardware and Department of Computer Software, for example, "faculty members claimed they read anywhere from 1,030 to 25,500 pages of professional literature[4] each year, with the average being 5,558 pages." Native English speakers read on average 10,667 pages of profession-related English and non-native English speakers from 12 other language groups read 3,308 pages of English on average (Orr, 1995b, p.21). With such a tremendous load of information for the human brain to process, clever writing and organizational strategies must be employed to manage this input and make it readily accessible when needed.

2) Input-Directed Writing

Purpose: to obtain information, approval, assistance, resources, etc.

e.g., stand-alone e-mail questions and requests, proposals, calls for papers

3) Process-Directed Writing

Purpose: to facilitate the information creation process

e.g., diagrams and mathematical formulas annotated with notes and memos

4) Output-Directed Writing

Purpose: a) to disseminate information to (re)define and/or advance the profession and its membership or b) to contribute to the profession's knowledge base

a) community-building writing

e.g., research lab home pages, biographical sketches, letters from an editor or SIG (Special Interest Group) chairperson

b) knowledge-building writing

e.g., technical reports, conference papers/proceedings, journal articles

[4]Professional literature refers to all print and digital profession-related text such as journal articles, calls for papers, conference proceedings, technical reports, e-mail correspondence with other researchers, Internet discussion on computer science lists, instruction manuals, Web pages, books, product catalogues, etc.

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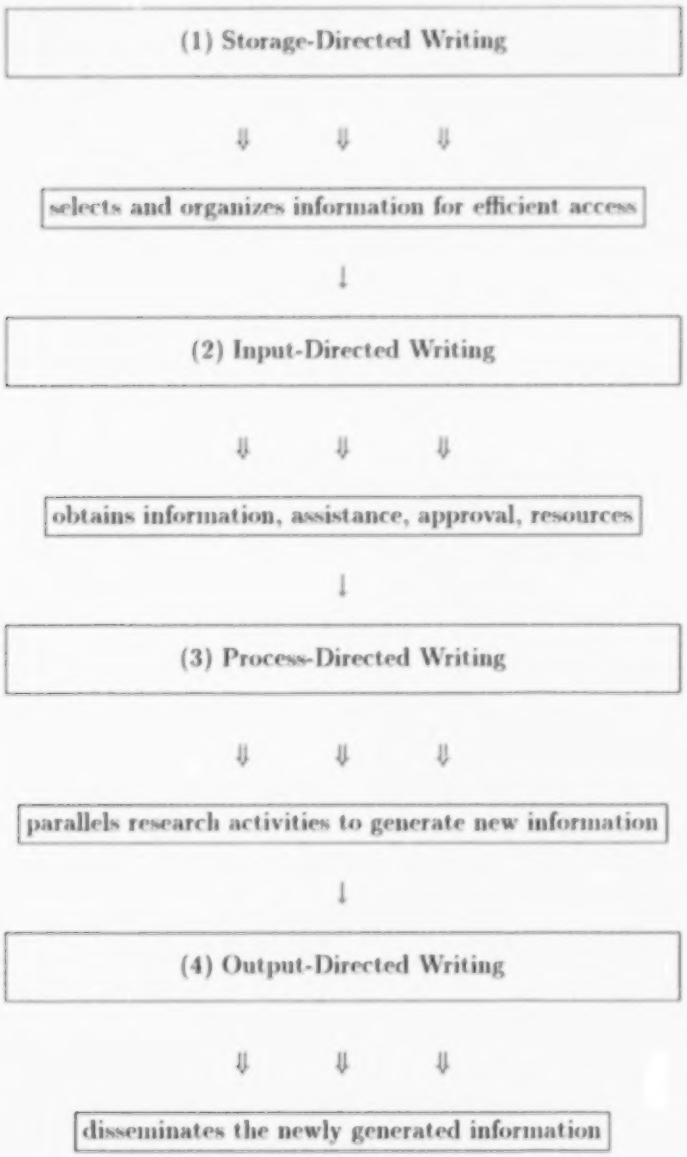
3.4 Diagram of the Four Primary Writing Functions


(1) Storage-Directed Writing
selects and organizes information for efficient access
(2) Input-Directed Writing
obtains information, assistance, approval, resources
(3) Process-Directed Writing
parallels research activities to generate new information
(4) Output-Directed Writing
disseminates the newly generated information

For other, more detailed models of professional writing practices in the computer sciences, see Orr, 1995b.

To help orient computer science students to the writing characteristic of computer science, it is best to prioritize information according to immediate need and/or frequency of use. The English writing instruction that is covered in freshman Composition 1 and 2 at the University of Aizu, for example, consists of the following:

3.5 Genres Selected for Instruction (Freshman Composition)

- digital dialog
  - simple two-person exchanges (simple questions and answers)
  - complex multi-person exchanges (well-anchored discussion)
- object descriptions
  - short autobiographical sketches (1-3 sentences)
  - longer autobiographical sketches (1-3 paragraphs)
  - electrical product description (e.g., camera, laptop computer, pager)
- narratives
  - short, reflective accounts of past events
- process descriptions
  - directions on how to perform a computer function (e.g., add sound to a Web page)
  - explanation of how something works (e.g., a computer mouse)
- abstracts and bibliographies
  - abstract of a longer piece of writing in the computer sciences
  - annotated bibliography

More complex genres are covered in Technical Writing 1 and 2, Advanced Writing, and Research Methods, and applied in computer science courses, graduation research, and in the graduate school scheduled to open April 1, 1997.

3.6 Language Features

In addition to genre, an EST writing course should also direct some specific attention to vocabulary and grammar items frequently employed in computer science discourse. Here are a few items that we address when teaching computer science students:

3.6.1 Specialist Computer Science Vocabulary

areal density, benchmark, command queuing, femtosecond, hypercube, LISP, synchro-stratum, thermionic, Unicode, wafer, WAIS[5]

[5]This vocabulary is primarily taught by computer scientists who cover this material in computer science courses. Language faculty teach the English used in the definitions and explanations of these specialist terms.

3.6.2 Non-Specialist Computer Science Vocabulary

computer screen, click, delete, e-mail, file, font, key, keyboard, highlight, Internet, menu, mouse, printer, scan, Web page, window, World Wide Web (vs. Worldwide Web)[6]

3.6.3 High Frequency General English Vocabulary

analysis, application, device, efficient, human, management, perform, problem, project, research, results, such, time, use, verify, which[7]

3.6.4 High Frequency or Problematic Grammatical Features

Adjective Clauses

Example: This paper discusses some general requirements for CASE tools *which support object-oriented software development.*

Passives

Example: In this paper, a model of a heterostructure bipolar transistor incorporating an RT collector structure *is developed and discussed.*

Anthropomorphization (inanimate subjects with active verbs)

Example: computers *perform*, the screen *shows*, a computer program *instructs*, this paper *presents* (This seems to be especially problematic for Japanese. See Kojima, S., & Kojima, K., 1978.)

For those interested in viewing specific writing course syllabi, homework assignments, and instruction material used at the University of Aizu, point your favorite Web browser at the Center for Language Research on the University of Aizu campus. Here some of our faculty have begun putting courseware and research papers on WWW to provide more efficient access.

http://www.u-aizu.ac.jp/public/www/labs/clrs/welcome.html#to

[6] This vocabulary is taught by language teachers.
[7] See Orr, T. Christianson, K., Goetze, C., & Okawa, H., 1995

4 Conclusion

As you can see, an EST writing program is characterized by EST faculty committed to research and instructional activities designed to understand and support the effective use of English in the scientific and/or technological disciplines of their students. EST writing professors must help students understand the goals and professional activities of their target profession, must introduce them to the writing that occurs within their target profession, and must help students learn to produce this writing by offering an intelligently prioritized curriculum. If Japanese universities employ EST faculty who can do this and develop EST programs that can successfully orient students to the written discourse of their major, Japan can better prepare her students to participate actively in the international exchange of research and knowledge within the science and technologies.

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